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Traffic Management system using IBM Internet of Things

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Chapter 1
INTRODUCTION

1.1 Project Definition

The project involves using IoT devices and data analytics to monitor traffic flow and congestion in real-time, providing commuters with access to this information through a public platform or mobile apps. The objective is to help commuters make informed decisions about their routes and alleviate traffic congestion. This project includes defining objectives, designing the IoT traffic monitoring system, developing the traffic information platform, and integrating them using IOT technology and Python.

1.2 Objectives

Improve traffic flow: Improve the efficiency of traffic flow by reducing delays by reducing
congestion at major intersections and sidewalks.
Enhance safety: Improve road safety by reducing accidents and ensuring smooth traffic shifts.
Reduce Environmental Impact: Reduce greenhouse gas and fuel consumption by reducing the time
vehicles spend idle in traffic.
Real-time analytics: Use real-time monitoring of traffic conditions and respond quickly to incidents.
Data-Driven Decision Making: Use data analytics to make informed decisions for traffic
management and infrastructure improvement.

Increase public transit integration: Encourage the use of public transit by aligning traffic lights and
roads with public transit systems.
Access Improvements: Increase accessibility for pedestrians and cyclists through improved
intersections and trails.
Scalability: Ensure the system can scale to meet future developments and technological
developments.

1.3 Requirements:

Traffic Sensors: Place sensors (e.g., cameras, ultrasonic sensors, pressure sensors) at key locations to
collect real-time traffic data
Centralized Control Center: Establish a centralized control center to manage and monitor the
vehicle system.
Smart traffic lights: Use smart lights that can adapt to traffic conditions and prioritize certain traffic
patterns.
Communication system: Create a reliable communication system to transfer data between sensors,
control center, and traffic lights.
Data Analytics Platform: Use a data analytics platform to process and analyze incoming traffic data.
Machine Learning Algorithms: Develop machine learning algorithms to predict traffic patterns and
optimize traffic light timings.
Real-Time Data Display: Create user-friendly dashboards and mobile apps for the public to access
real-time traffic data.
Public Awareness Campaign: Launch a public awareness campaign to inform drivers and
pedestrians about the smart traffic management system.
Traffic Light Synchronization: Ensure that traffic lights are synchronized with public transport

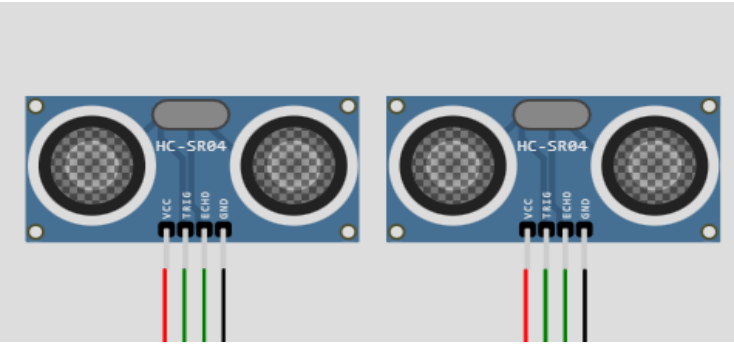
schedules.
Scalable Architecture: Design a scalable system that can adapt to increased traffic and new
technologies.

Chapter 2
Hard Ware Requirements

2.1Required sensors

Ultrasonic sensors: Ultrasonic sensors are suitable for measuring the distance between the sensor and
nearby vehicles, and providing information on traffic volume and flow speed.
Infrared sensors: Infrared sensors can detect the presence of vehicles by measuring changes in
infrared radiation. They work well for controlling traffic flow.
Car recognition cameras:Raspberry Pi Camera Module: This camera module is a cost-effective solution for recording photos
and videos. It can be used for vehicle identification and license plate identification (LPR).
USB Webcams: USB webcams are easy to connect to the Raspberry Pi and provide video data that
can be used for real-time monitoring.
Environmental Awareness:
Thermal properties: Thermal properties can provide environmental issues that can affect road
conditions such as icy roads in winter.
Moisture content: Moisture content can help measure weather conditions and their impact on road
safety.
Traffic light cameras:
These cameras are used to monitor traffic lights at intersections. They ensure that the system can
adjust traffic light timing according to traffic conditions.

License Plate Recognition (LPR) Camera (Optional):
LPR cameras can be used for advanced applications such as monitoring entry and exit points, tracking traffic violators and collecting fines.



2.2 Raspberry Pi

Raspberry Pi 3 (or a model of your choice)
Power supply for the Raspberry Pi
MicroSD card with Raspbian OS (or your preferred OS)
USB peripherals (keyboard, mouse, and a monitor for initial setup)

Chapter 3
Software Requirements

3.1 Python Software :

Python code for interfacing with sensors and cameras and sending data to Azure IoT Hub

CODE:

```
import time
import random
from azure.iot.device import IoTHubDeviceClient
CONNECTION_STRING = " HostName=hostforiotproject.azure-devices.net;DeviceId=raspberry-pi-004;SharedAccessKey=qghd30aseqgh456sd"
```

```
client = IoTHubDeviceClient.create_from_connection_string(CONNECTION_STRING)
def simulate_sensor_data():
temperature = random.uniform(10.0, 40.0)
humidity = random.uniform(20.0, 80.0)
return {"temperature": temperature, "humidity": humidity}
def preprocess_and_filter(data):
if data["temperature"] < 0 or data["temperature"] > 50:
return None
if data["humidity"] < 0 or data["humidity"] > 100:
return None
return datawhile True:
try:
sensor_data = simulate_sensor_data()
processed_data = preprocess_and_filter(sensor_data)
if processed_data:
message = str(processed_data)
client.send_message(message)
print(f"Message sent: {message}")
time.sleep(10)
except Exception as e:
print(f"Error: {str(e)}")
client.shutdown()
```

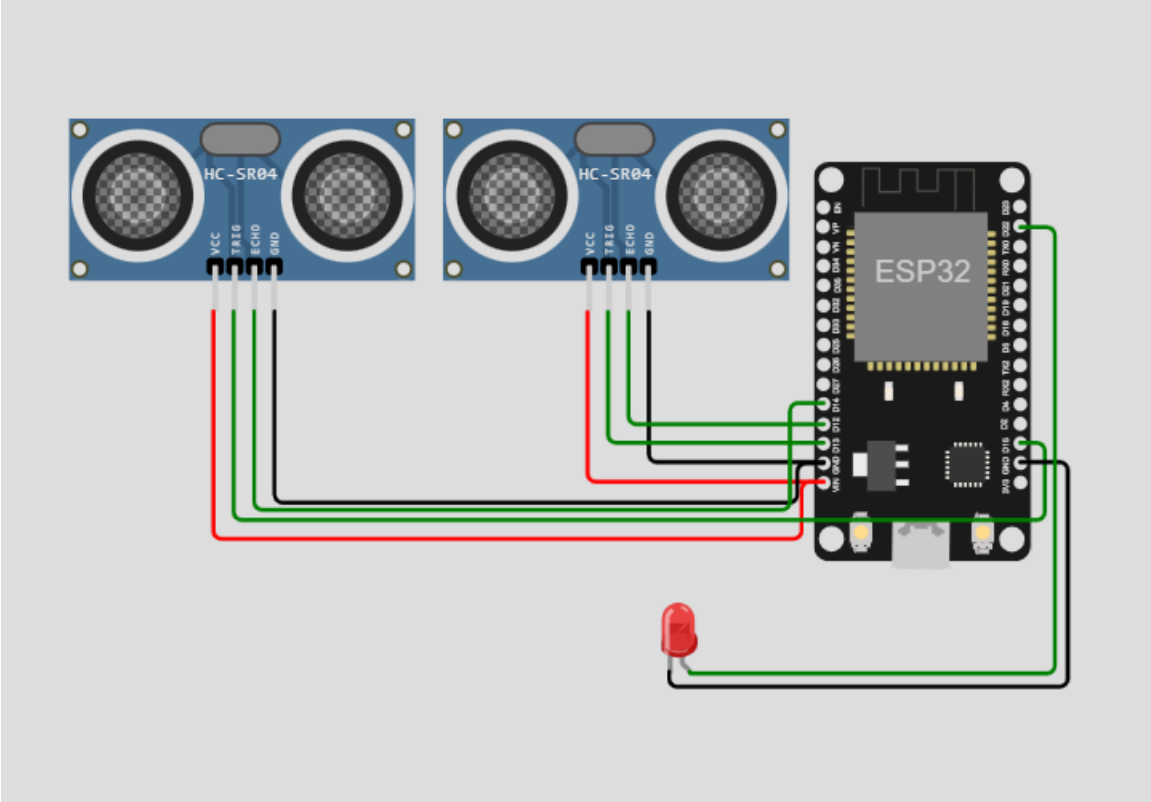
3.2 Azure IoT Hub Setup

Signed in to Azure IOT Hub
Registered RaspberryPI as device in azure IOT Hub and received Connection string

3.3 Azure IoT Cloud Simulator

Objective: Develop a virtual testing environment for traffic scenario simulation.
Accomplishments: Successfully set up and configured the Azure IoT Cloud Simulator, enabling the

creation of virtual traffic scenarios.
Highlights: Created device templates and simulation models that accurately mimic real-world traffic
behaviors, allowing for rigorous testing and validation.



3.4 Data Transmission

Objective: Enable secure transmission of sensor data from Raspberry Pi devices to Azure IoT Hub.
Accomplishments: Modified Raspberry Pi code to send sensor data using connection strings, with
robust security measures, including TLS.
Highlights: Achieved secure and reliable data transmission, ensuring that real-time traffic data
reaches the Azure cloud for processing.

3.5 Data Processing and Analysis

Objective: Implement real-time data processing and traffic analysis in the Azure cloud.
Accomplishments: Set up Azure services like Azure Stream Analytics, Azure Functions, and Azure
Machine Learning for data processing.
Highlights: Implemented advanced traffic management logic, including real-time congestion
detection and other features to improve traffic flow.

3.6 Visualization and User Interface

Objective: Create user-friendly dashboards for real-time traffic data visualization.
Accomplishments: Developed web-based and mobile dashboards using Azure Web Apps and Power
BI.
Highlights: The system provides a visually rich interface for both traffic operators and the public to
monitor traffic conditions and receive alerts.

3.7 Testing and Optimization

Objective: Rigorously test and optimize the entire system for performance and reliability.
Accomplishments: Successfully tested the system's components, including sensor accuracy, data
transmission, cloud processing, and visualization.
Highlights: Extensive optimization efforts were made to ensure the system's performance and
scalability, providing real-time traffic insights with precision.

3.8 Deployment

Objective: Deploy the smart traffic management system in a real-world traffic environment.
Accomplishments: After thorough testing and optimization, the system has been deployed in the
desired location.
Highlights: The system is now actively managing traffic, optimizing signal timings, and providing
real-time traffic information to commuters, contributing to safer and more efficient transportation.

3.9 Monitoring and Maintenance

Objective: Implement continuous monitoring and maintenance procedures to ensure system
reliability.
Accomplishments: Established monitoring mechanisms for real-time traffic data and system health.
Highlights: Proactive maintenance and system adjustments are ongoing to maintain system
performance and reliability, keeping urban traffic .

Chapter 4

Conclusion

Effective traffic management is essential for ensuring smooth transportation, reducing congestion, and enhancing overall urban mobility. Implementing intelligent solutions, such as IoT-based traffic monitoring systems, plays a pivotal role in achieving these objectives. By leveraging advanced sensors, data analytics, and real-time insights, cities can

optimize traffic flow, enhance safety, and minimize environmental impact.

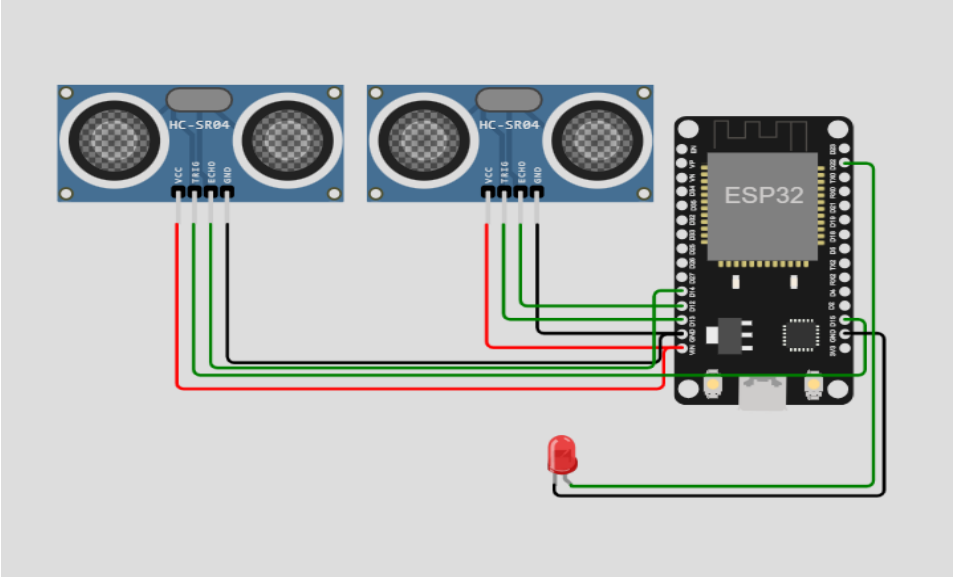
Chapter 5

Source Code

```
#define BLYNK_TEMPLATE_ID "TMPL26V4fGv5q"
#define BLYNK_TEMPLATE_NAME "Test"
#define BLYNK_AUTH_TOKEN "XEHxNF_Ur1Nt2p7wB5B20dNI1ZUwj34P"

#include <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>

int duration1 = 0;
int distance1 = 0;
int duration2 = 0;
int distance2 = 0;
int dis1 = 0;
int dis2 = 0;
int dis_new1 = 0;
int dis_new2 = 0;
int entered = 0;
int left = 0;
int inside = 0;
#define LED 2
#define PIN_TRIG1 15
#define PIN_ECHO1 14
#define PIN_TRIG2 13
#define PIN_ECHO2 12
BlynkTimer timer;

char auth[] = BLYNK_AUTH_TOKEN;
char ssid[] = "Wokwi-GUEST";   // your network SSID (name)
char pass[] = "";
#define BLYNK_PRINT Serial

long get_distance1() {
  // Start a new measurement:
  digitalWrite(PIN_TRIG1, HIGH);
  delayMicroseconds(10);
  digitalWrite(PIN_TRIG1, LOW);
```

```
  // Read the result:
  duration1 = pulseIn(PIN_ECHO1, HIGH);
  distance1 = duration1 / 58;
  return distance1;
}

long get_distance2() {
  // Start a new measurement:
  digitalWrite(PIN_TRIG2, HIGH);
  delayMicroseconds(10);
  digitalWrite(PIN_TRIG2, LOW);

  // Read the result:
  duration2 = pulseIn(PIN_ECHO2, HIGH);
  distance2 = duration2 / 58;
  return distance2;
}

void myTimer() {
  Serial.println("100");
  dis_new1 = get_distance1();
  dis_new2 = get_distance2();
  if (dis1 != dis_new1 || dis2 != dis_new2){
    Serial.println("200");
    if (dis1 < dis2){
      Serial.println("Enter loop");
      entered = entered + 1;
      inside = inside + 1;
      digitalWrite(LED, HIGH);
      Blynk.virtualWrite(V0, entered);
      Blynk.virtualWrite(V2, inside);
      dis1 = dis_new1;
      delay(1000);
      digitalWrite(LED, LOW);
    }
    if (dis1 > dis2){
      Serial.println("Leave loop");
      left = left + 1;
      inside = inside - 1;
      Blynk.virtualWrite(V1, left);
      Blynk.virtualWrite(V2, inside);
      dis2 = dis_new2;
      delay(1000);
    }

  }
```

```
}

 void setup() {
  Serial.begin(115200);
  pinMode(LED, OUTPUT);
  pinMode(PIN_TRIG1, OUTPUT);
  pinMode(PIN_ECHO1, INPUT);
  pinMode(PIN_TRIG2, OUTPUT);
  pinMode(PIN_ECHO2, INPUT);
  Blynk.begin(auth, ssid, pass, "blynk.cloud", 8080);
  timer.setInterval(1000L, myTimer);

}

void loop() {
  Blynk.run();
  timer.run();
}
```



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